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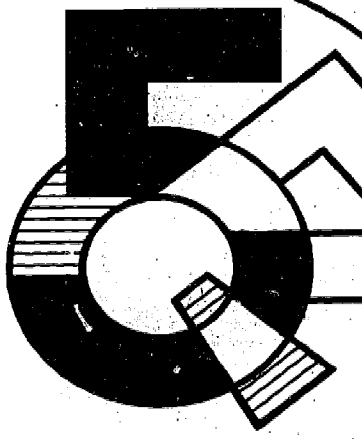
ABSTRACT

A course in sculptural art in the areas of welding, brazing and soldering is presented. The objective of the course is to introduce the student to these aspects of metal sculpture. Course content includes techniques in metal sculpture. (CK)

AUTHORIZED COURSE OF INSTRUCTION FOR THE QUINMESTER PROGRAM



DADE COUNTY PUBLIC SCHOOLS

Art Education: SCULPTURE METALLIC FORMATIONS I 6683.12

DIVISION OF INSTRUCTION • 1971

SCULPTURE

METALLIC FORMATIONS I

6683.12

ART EDUCATION

Written by: Edward R. Dubocq

for the

DIVISION OF INSTRUCTION
Dade County Public Schools
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TABLE OF CONTENTS

I. COURSE TITLE:

METALLIC FORMATIONS I

II. COURSE NUMBER: 6683.12

III. RATIONALE:

Sculpture: "Plastic or hard materials that have been welded, carved, engraved, molded, or constructed into a primarily three dimensional work of art."

It is important that any student of art become acquainted with the various areas of sculpture. We are constantly surrounded with varying forms of sculpture in our natural environment.

Sculpture can entail any three dimensional form around us from a tree to a building. Sculpture affects every day of our lives be it through an object that is simply pleasing to the eye, or the pure functionality of a unit of sculptured steel, the modern automobile.

Due to the scope and amount of material relative to metal sculpture, this area has been divided into two Quinmester Outlines as follows:

Part I:

Welding, Brazing, and Soldering

Part II:

Casting; and non-heat involved forms of metal sculpture (hammering, riveting, etc.)

IV. COURSE DESCRIPTION:

A. Elective grades 7-12, exploratory

B. Textbooks and other materials;

Text materials, visuals, vocabulary lists, etc., should be selected from examples listed in parts IX and X of this Quinmester Course of Study. It is suggested that references marked with an asterisk be kept on hand for student use in the classroom.

C. Vocational Scheme:

To introduce the student to the areas of welding, brazing, and soldering as related to metal sculpture, and to prepare the student for more advanced techniques and courses in the area of Sculptural Art.

D. Method: (by week)

1. Lecture
2. Demonstration
3. Studio experience
4. Critique and evaluation

E. Synopsis:

Note: There are suggested presentation outlines for each of the sub headings in this section. They are located in part VIII.

Study:

1. Introduction to
   a. History
   b. Appreciation
2. Techniques in metal sculpture
   a. Selection of metal
   b. Oxyacetyline welding technique
   c. Electric arc-welding technique
   d. Soldering technique
   e. Brazing technique
   f. Surface treatment
   g. Base design and creation

3. Studio work

4. Critique

V. ENROLLMENT GUIDELINES

A. Prior Courses: None

B. Evaluative device:

Empirical testing should be followed

C. Concurrent programs:

There is no specific program that must be taken concurrently

VI. BEHAVIORAL OBJECTIVES

A. Competencies expected upon completion of this unit:

The student will be able to:

1. Describe the procedures for the following metal sculpting techniques:

a. Selection of metal

b. Oxyacetyline welding

c. Electric arc-welding

d. Soldering

e. Brazing

f. Surface treatment

g. Base design and creation

2. Define orally or in writing, related vocabulary terms as listed in part VIII of this Quinmester Course of Study.
3. Differentiate among a minimum of four metal sculptors from past and/or contemporary art movements.
4. Manipulate metal sculpting tools and related materials according to individual specifications.
5. Create open and closed forms in metal through manipulation of sculptural tools and related materials.
6. Compare and differentiate among various metals and their abilities to be sculpted.
7. Practice the correct procedures for working in a metal sculpting studio.
8. Create a minimum of two sculptural examples from the list of techiques in part VIII of this course outline.
9. Compare the types of surface treatment described in part VIII and select one or more types for application to sculptural examples.

10. Apply the selected surface treatments to sculptural examples.
11. Construct a compatible base for each of the two metal sculptures created.

B. The student will demonstrate competencies under the following conditions:
   1. Classroom demonstration
   2. Classroom discussion
   3. Individual research
   4. Individual studio procedures
   5. Group critiques
   6. Empirical testing

C. Acceptable preformance will be determined by the individual instructor on the basis of
   1. Evaluation of classroom participation
   2. Required projects turned in for grade
   3. Emperical testing
   4. Test items based on the performance objectives

VII. COURSE CONTENT:

A. Introduction

1. Lecture

a. Worksheets

b. Suggested or required reading

2. Films

a. Sculpture qppreciation

b. Sculpture history

c. Metal sculpture techniques

3. Demonstration

4. Resources

a. Suggested reading

b. Work sheets

c. Filmstrips

d. Films

5. Discussion

B. Metallic formation techniques

1. Materials

2. Tools

3.. Storage and care

C. Metallic formation techniques

1. Selection of metal
2. Oxyacetyline welding
3. Electric arc-welding
4. Soldering
5. Brazing
6. Surface treatment
7. Base design and creation

D. Studio experience

E. Critique

1. Individual
2. Group

VIII. COURSE PROCEDURES, STRATEGIES, AND SUGGESTED LEARNING ACTIVITIES:

A. Vocabulary list

Sculpture: Plastic or hard materials that have been carved, engraved, molded, welded, or contructed into a primarily three dimensional work of art.

Sculptor: One who sculpts, or creates sculpture.

1. Acetylene: A gas used in conjunction with air or pure oxygen to braze, hard-solder, or weld metal.
2. Airacetylene: A combination of air and acetylene used to hard-solder or braze metal. May reach 2500°F. when burned. (Not hot enough to weld.)
3. Alloy: A secondary metal composed by the permanent fusion of two or more primary metals or substances.
4. Anneal: To heat metal in order to strengthen it during welding or shaping.
5. Arc welding: The use of electricity in welding (as opposed to gas.)

6. Asbestos: A heat resistant material used as an insulator.

7. Backfire: A loud popping noise caused by a dirty torch tip, or touching the tip of the torch to the metal being welded. The noise is made when the flame goes out.

8. Base metal: The piece of metal being cut or welded.

9. Brazing: Joining metal with the use of a filler metal that has a melting point lower than the base metal, but higher than 1,000° F. (More similar to soldering than welding.)

10. Carburizing: A carbon build up on the metal surface, due to excess acetylene in the torch flame.

11. Closed form: A form being solid in appearance; having no holes or cavities. A form that encloses space.

12. Corrosion: The dissolving, or eating away of metal, usually by natural elements. (Example: rust.)

13. Feather: A yellow cone surrounding the inner cone of a flame consisting of too much acetylene.

14. Ferrous: Metallic compounds containing iron.

15. Filler: The metal added to the base metal in welding. (Usually in rod form.)

16. Flashback: A loud hissing sound caused by the flame burning back into the torch. (Note: Turn off all valves immediately!)

17. Flux: A compound used in welding to burn off oxides from the surface of the metal to be joined.

18. Fusion: The complete and permanent joining of two metals.

19. Galvanizing: Coating a metal with zinc, usually to prevent rust.

20. Kerf: The notch or space left in metal when it is cut by heat.

21. Media: Any substance used in the creation of metal sculpture.

22. Melting point: The temperature at which metal becomes a liquid..

23. Non-Ferrous: A metal that does not contain iron.

24. Open form: A form containing hollow areas, cavities, or holes (as opposed to closed forms.)

25. Oxidation: The burning of metal caused by its combination with oxygen.

26. Pass: The deposit of metal left along the line of a weld.

27. Patina: The color of the surface of metal, usually caused by impurities, oxidation, or applying acidic substances.

28. Plate: Sheet metal thicker than 1/8".

29. Puddle: An area of molten metal formed during welding.

30. Quenching: Cooling a metal by dipping it into a liquid—usually causing brittleness.

31. Rod: A length of metal used as a filler in welding.

32. Sheet metal: Any metal up to 1/8" thick.

33. Soldering: Fusing metals at a low temperature with a metal that melts at a lower temperature than the base metal.
(Hard soldering 1,200°-1,300° F.)
(Soft soldering 700° F. and below)

34. Studio: Any area designed for, or in which artistic creation takes place.

35. Texture: The tactile, structural surface of a work of art.

36. Tip: The head of a torch, from which the flame appears. (Removable.)

37. Welding: The process by which two pieces are reduced to their melting points and are fused directly together.

B. Procedure:

(Suggested instructor demonstration aid.)
The general procedures that apply to all forms of sculture will be discussed in this section. Individual procedures for specific sculptural techniques will be listed and described on the work sheets.

The primary guideline applying to all forms of sculpture is good three-dimensional design. In sculpture, one must relate his design to a free standing form that will be viewed from all sides. This fact should be kept in mind when designing sketches or models. If a sculpture has been well disigned, it will be pleasing to the eye from any angle.

As in painting or collage, the basic design should be developed through a series of thumb-nail sketches or clay models. Develop an idea of what the sculture will look like before beginning to sculpt. By doing a series of "shape" or "form" models, the student will discover certain forms that appeal to this artistic style.

Another factor to consider is the base, or stand that will support the finished sculpture. It is easy to make the mistake of designing a base that detracts from the visual effect of the sculpture itself. Remember that when a base is used, it becomes a part of the sculpture. It should relate to the sculpture, and yet be subtle in its relationship.

Finally, in creating your sculpture, try to have the finished piece show "movement." A piece of sculpture that appears to relate "movement" or "action" has a greater and more pleasing visual impact than one that is stagnant or unmoving.

There are more specific steps and processes in the creation of metal sculpture. They are outlined in the work sheets included in this Quinmester Course of Study.

C. Materials and supplies needed:

Metal (see work sheet)

Miscellaneous chemicals for patina (see work sheet)

Welding table (metal or fire brick top)

Assorted rods and fluxes

Metal pails for dipping

Hammers (assorted: flat, ball peen, etc.)

Pliers (assorted; pointed, blunt, etc.)

Files (assorted; coarse, fine, small, large, etc.)

Welders goggles

Protective gloves

Asbestos board (for soldering)

Anvil

Spring clamps and assorted metal clamps

Burnishing tools

Emory paper

Steel wool

Air acetylene equipment

Oxyacetylene equipment

Soldering iron

Soldering paste

Soft lead solder

Resin core solder

Small brushes

Tin snips and metal shears

D. Studio procedures for students

(This list may be duplicated and distributed to individual students.)

1. Each student will be assigned an individual work and storage area which be or she will be responsible for.
2. Equipment will be distributed on a sign-out basis. Students will be expected to demonstrate correct care for and use of materials.
3. Student will not be permitted to use, touch, or move another students project or materials.
4. Monitors will be assigned in certain areas as aides to the instructor.
5. <u>All</u> students will be expected to stop work and begin clean up promptly, approximately five minutes before the end of each period.
6. Students will, at all times, be expected to maintain a "professional" attitude towards their work, equipment, fellow students, and instructor.

E. Hints for instructors:

1. There are many visual aids available. Plan to order movies, slides, etc., well in advance.
2. Design the studio so that there is a specific storage area for all supplies. (This insures a quick method for checking materials before the end of each period.)
3. Assign monitoring positions to students, on a rotating basis.
4. Students should "sign out" tools and equipment.
5. Stringently reinforce the role of wearing protective goggles when welding.
6. Be sure that individual welding areas are adequately separated.
7. Stress the use of protective gloves.
8. Keep a first aid kit containing burn salve, etc., on hand.

F. Work sheets:

Note: The following work sheets have been designed as direct teaching aids for student use. They may be duplicated "as-is" and distributed to students for reference following the instructor's demonstrations.

WORK SHEET--METALLIC FORMATIONS I

Selection of Metals

The following is a list of metals, their characteristics, and applicability to various sculpting techniques.

Metals fall basically into two categories--pure metals, and alloys. The category of alloys may be further categorized into two categories: ferrous (magnetic--containing iron) and non-ferrous (not magnetic--containing no iron.)

I. FERROUS METALS

A. Iron: Iron is obtained by melting ore in a blast furnace and extracting the iron from the ore. In its refined state, the metal is commonly known as "pig iron." Pig iron is used in creating two other metals, wrought iron and cast iron. Wrought iron is relatively easy to heat and work, as is pig iron. Cast iron is generally brittle and difficult to weld. For this reason, cast iron is not recommended for use in this unit.

Wrought iron may be procured easily and inexpensively at local junk yards. It is applicable to both welding and casting.

B. Steel: Most pig iron is used in the creation of steel. Steel is an alloy of iron, carbon, and other miscellaneous materials. It is stronger than iron. There are many different varieties of steel, and it is also used in conjunction with other metals to create numerous alloys.

Steel melts at lower temperatures than iron and is also less expensive. It is one of the most popular metals for sculpting due to its low cost, accessability, and strength.

II. NON-FERROUS METALS:

A. Aluminum: Aluminum is a light-weight, non-corrosive metal often used for outdoor sculpture. It has a low melting temperature and is basically soft. Aluminum is used more frequently for casting as it presents problems when welded. It requires a special flux that also tends to corrode the metal, and is likely to collapse without warning from excessive heat. Aluminum may be soldered with much greater ease but still requires a special flux. It is more expensive than steel, and is more difficult to procure second hand, due to re-cycling.

B. Lead: Lead is a very soft metal. It has a low melting point (150°-625° F.), and is generally used for casting. In most cases it is generally fused with a soldering iron. Lead may be easily worked with many direct carving tools (not applicable for welding.)

C. Copper: Copper is a relatively soft metal that presents some difficulties in welding. (De-oxidized

copper is the best type for welding, as it is stronger.) Due to the amount of expansion and contraction caused in copper by welding, care must be taken to prevent the form from becoming distorted. Copper also diffuses heat more rapidly than most other metals, therefore requiring a larger torch tip than steel. Copper is prone to sudden collapse and/or liquefying from excessive heat. (Not recommended as a beginning metal.)

D. Bronze: Bronze is an alloy of tin and copper. (Appx. 90% copper-10% tin) The addition of tin makes bronze a much stronger, and easier metal to work than pure copper. Bronze is applicable to both casting and welding. It is a good heat conductor and may also be brazed and soldered. The melting point of bronze is between 1,300°-1,900° F. It may also be hammered and shaped easily, in thinner sheets.

E. Brass: Brass is a copper-zinc alloy, usually containing 10%-40% zinc. Like bronze, brass is harder, stronger, and more easily worked than pure copper. It is also quite mallable, and maybe shaped easily.

There is one danger involved in the welding of brass. It may produce dangerous fumes that can be harmful to the welder. It is for this reason that brass is usually soldered or brazed, as opposed to fusion welding. There are methods for welding brass, but these methods involve special rod, flux, and welding abilities. (Not recommended for fusion welding.)

There are many other metals available to the sculptor, however this selection is adequate for a fundamental course. Steel and bronze are the best selections for welding. Bronze, brass and lead are the best for soldering, and almost any of the above, with the exception of lead, may be brazed with relative ease.

WORK SHEET--METALLIC FORMATIONS I

Oxy-acetylene Welding

Acetylene welding is one of the most exciting sculpture processes available to the artist today. The process itself involves melting and joining metal with an intense flame (above 5,000° F.) consisting of compressed oxygen mixed with compressed acetylene.

Oxy-acetylene welding was discovered in 1895 by a chemist named Le Chatelier. The first application of the process for creating sculpture was made about 1928 by Julio Gonzalez. He was soon joined by Pablo Picasso and later, David Smith. By then, oxy-acetylene had become a well known method of sculpting metal.

I. EQUIPMENT:

The following equipment is necessary in the process of oxy-acetylene welding:

A. Oxygen and acetylene cylinders.

These cylinders are under pressure (oxygen 2,000 lbs. p. s. I.—acetylene 250 lbs. p. s. i.) and should be treated with great care. Cylinders should be stored and used in an upright position and should be firmly sec red in place.

B. Regulator and gauge: This equipment is attached to the cylinders. They consist of a shut off valve to regulate flow, and two gauges per cylinder; one to indicate tank pressure, and one to indicate flow pressure.

C. Gas hoses: These hoses run from the tanks to the torch, and carry the flow of gasses (separately). They are color-coded (oxygen-green/acetylene-red) and have indicator marks on the connecting nuts as further safety precautions.

D. The torch: The oxy-acetylene torch is a metal instrument which combines the two gasses for welding. There are pressure flow adjustment valves on the torch to regulate the flame, (depending on the type and thickness of metal to be welded.) This is the tool that the artist actually holds in his hand and welds with. (Torches come with interchangeable tips for various welding techniques.)

There are two basic torches; one for welding and one for cutting. The use of these will be discussed later.

E. Goggles: Special goggles are used to protect the

eyes from the flame when welding. Always wear them when working with the torch.

F. Protective clothing: It is advisable to wear hard-surface shop overalls, as thin material such as shirts, sweaters, etc.,may catch afire from hot metal pieces and droppings.

G. Gloves: Asbestos gloves are the best type for arc welding.

H. Miscellaneous tools: Hammers, metal cutters, clamps, pliers, and wrenches in assorted sizes are needed for working the metal.

I. Sparker: A small hand device that creates a spark for igniting the flame is needed.

J. Studio arrangement: Welding involves a great deal of heat, therefore care should be taken to remove any and all combustible matter from the welding area.

II. PROCEDURE:

A. Setup:

1. Read carefully instructions on care of equipment. (Supplied with welding equipment.)
2. Check to see that all hoses have been connected correctly.
3. Open the regulator wheel on the oxygen tank 1/2-3/4 of one turn.
4. Turn on oxygen regulator to between 5 and 10 lbs. pressure. (Refer to reference books for exact setting needed for your particular metal.)
5. Open regulator wheel on acetylene tank 1/2 turn and adjust flow valve as in step 4 for oxygen.
6. Open oxygen valve on torch and adjust oxygen regulator on tank to desired pressure. Then close valve on torch.
7. Do the same to acetylene valve. (You are now ready to weld.)

B. Torch operation:

1. Open the acetylene valve on the torch 1/4 turn and ignite the gas with the striker.

(This will cause a "feathery" shaped yellow flame with a great deal of smoke.) Continue to open the valve until the flame jumps slightly away from the tip.

2. Gently open the oxygen valve until the feathering flame disappears and a sharp, inner cone appears. This will be the correct flame for welding. (Called a "neutral" flame.)

Note: °If the flame is still large and yellow, cut down on the acetylene.

°If the flame (inner cone) becomes small and there is a hissing sound, cut down on the oxygen.

C. Checking for leaks:

Frequently check the apparatus for gas leaks when welding. Use a clean brush, and apply clean soapy water to all joints. (If there is a leak, bubbles will appear.)

D. The weld:

Oxy-acetylene welding is a process that cannot be hurried. Like any other form of sculpture, welding

is an art and must be planned, controlled, and executed in an artistic manner. There are hundreds of interesting effects that can be achieved with oxy-acetylene, and the best way to learn these is through experimentation. The technique consists of melting both edges of the parent metals to one another. Hold the flame slightly above the surface of the metal, proceeding slowly forward at about a 30^{o} angle. (This will pre-heat the metal you are approaching.) By using a small, circular motion as you proceed, the metal will "pupple" under the flame and run together.

The speed at which you move the flame along is dictated by the type and thickness of the metal. The most difficult skill to acquire is to control the puddling so that the metals melt and flow together, rather than burn apart. In this case, "practice makes perfect."

In some cases, you will need to use a rod of filler metal to help join areas or fill in holes. These rods come in many types and diameters. Use the reference materials to select the rod compatible to your work.

E. Common Problems and Solutions:

1. Flashback: This is when the flame burns back into the torch tip.
   a. Shut off all valves
   b. Clean the tip
   c. Re-check gas pressures in relation ot tip size
2. Brittle weld: Improper gas mixture
3. "Popping": a. Wrong size tip
   b. Incorrect pressure
   c. Touching the tip to the metal
   d. Clogged tip
4. Burning holes in the metal:
   a. Holding the flame in one place too long
   b. Too large a tip
   c. Too much pressure

F. Oxy-acetylene cutting:

A special torch is used in cutting. It has several holes in the tip, and a press lever that introduces high pressure oxygen flow to the flame.

1. Preheat the metal to a cherry red color.
2. Hold the tip in a vertical position, and depress the oxygen lever. (This will cause a

shower of sparks from cutting, to appear on the opposite side. This indicates correct cutting is taking place.)

Proper pressures for this process are

- Oxygen--30-70 p. s. i.
- Acetylene--3-6 p. s. i.

Note: Take special precautions to prevent burning or fires due to the great amount of sparks caused by the torch.

There are certain steps that relate to welding various metals. These steps (correct rod, tip, pressure, etc.) may be found in the research materials listed in this course, and supplied in the classroom.)

WORK SHEET—METALLIC FORMATIONS I

Electric Arc Welding

Note: Due to the expense of equipment and degree of danger involved with this process, it is recommended only for advanced students.

I. PROCESS:

Electic arc welding is similar to oxy-acetylene welding since the metals involved are joined by fusion. Arc welding involves the use of electricity rather than burning gas.

Arc welding is one of the hottest methods of welding, and is therefore used primarily on thick metal (3/8" and up). The principle behind arc welding is the completion of an electric circuit. An electric charge jumps from the electrode (rod) to the parent metal, causing a great amount of heat which, in turn, melts the rod leaving a weld deposit called the joint or seam.

Arc welding produces a very intense light which can damage the eyes. <u>It is mandatory to wear a protective mask, designed especially for arc welding whenever using the equipment.</u>

Before proceeding with this process, it is recommended that the student research information concerning voltage settings, rods, etc., in depth as they pertain to his or her particular project. Then consult the instructor as a double-check.

II. PROCEDURE:

1. Have adequate body protection; gloves, mask, long sleeves of heavy material.
2. Be sure floor area, and equipment is dry.
3. Check all wiring, cables, and voltage settings.
4. Use the correct electrode for your particular project.
5. If pieces to be joined need to be held in place, clamp them before starting to weld.
6. Once current is on, begin by "striking the arc" (Touching the electrode to the metal, causing a spark, then continuing on down the seam holding the electrode away from the metal, at a distance equal to the electrodes diameter.

   Note: If, at any time, the electrode fuses to the metal, remove it by twisting. If it still does not come off, carefully release it from the holder.

WORK SHEET—METALLIC FORMATIONS I

Soldering

Soldering is a form of low temperature brazing; since it requires a filler metal. There are two types of soldering, soft soldering, and hard (or silver) soldering. As hard soldering is relatively expensive, and may sometimes be substituted for brazing, we will discuss soft soldering in this unit.

Soft soldering involves the use of tin or lead as a bonding agent. It is usually available in wire form. Soft soldering is done in one of two ways: using a soldering iron, or air acetylene torch. Thin guage sheet metal (18-32 gauge) is usually soldered. Copper, brass, and steel are the most applicable metals.

I. SOFT SOLDER WITH A SOLDERING IRON:

A. Clean the metal thoroughly with an abrasive material.

B. Brush soft solder flux to the areas to be joined. (Zinc chloride flux works well on tin, steel, and copper.) Use plenty of flux.

Allow the iron to heat to a temperature sufficient to melt the solder when touched.
(Check for the correct solder and flux.)

C. Touch the solder to the iron tip until it begins to flow. Then move both the iron and solder along the joint, flowing the solder onto the flux and into the joint.

Allow to cool and wash off excess flux in a vinegar-water solution.

II. FLAME SOLDERING:

A. Follow steps 1 and 2 for soldering iron procedure.

B. Move the flame over the metal joint to heat metal and flux.

C. Touch the solder directly to the joint, allowing the heat of the parent metal not the flame to melt the solder.

D. Allow to cool and rinse with a vinegar-water solution.

(For additional information as to correct metal/rod/flux combinations, etc., see part IX.)

WORK SHEET--METALLIC FORMATIONS I

Brazing

I. PROCESS:

The basic difference between welding and brazing is that brazing does not fuse two metals directly to each other. In brazing, the temperature involved is above 800° F., and yet below the melting point of the metal to be joined. In the brazing process, a "filler" metal, (usually in rod form) bonds the pieces together. (Brazing is a form of hard soldering.)

In brazing, an air acetylene tip is used (except in the case of very thick metals, where oxy-acetylene may be necessary.) Usually, bronze rod is used in brazing, as it is quite strong and bonds most metals. Some metals will require a special rod, therefore, check for the proper combination in the reference materials.

II. PROCEDURE:

As in oxy-acetylene welding, clean the metal to be brazed thoroughly. Brazing rod filler will not flow on dirty metal surfaces.

Check to see that the correct rod, and flux if necessary, is being used.

If the metals to be joined need to be held together use a clamp.

Heat the parent metal to a cherry red color with the flame. While touching the metal with the tip of the rod, run the rod along the heated seam. (The heat of the metal will melt the rod.--Do not apply flame directly to the rod itself.) Be sure to use flux if needed.

Allow the metal to cool, then brush off excess flux with a wire brush.

Note: If the braze "boils" or "bubbles" and does not adhere, it may be due to:

A. Parent metal too hot
B. Parent metal too cold
C. Parent metal unclean
D. Touching the rod with the flame

III. SUGGESTIONS:

A. Be sure metal is clean.

B. Have adequate ventilation.

C. Use correct rod and flux.

D. Keep the molten rod flowing at the joint.

For additional references--see part IX (Resources for Pupils.)

WORK SHEET--METALLIC FORMATIONS I

Surface Treatment

There are two qualities of surface treatment involved in metal sculpture: texture and patina.

I. TEXTURE:

In this step you will decide the surface "feel" of your sculpture. Some shapes lend themselves to a highly refined and polished surface, while others create a more pleasing visual impact in a rough state. Some methods of texturing are

A. Hammering: By working the surface of a sculpture with a ball-peen or flat hammer you can achieve various light surface textures.

B. Filing: This process creates fine or coarse scratch marks on the surface (depending on the coarseness of the file used.)

C. Brazing: This process may also be used to create surface texture on a previously welded piece. (See work sheet on brazing.)

Note: Brazing may also be used to prevent corrosion.

II. PATINA:

The patina of a metal sculpture refers to the color of the metal, caused by impurities, oxidation, or acid application. There are many different patinas that may be created on various metal surfaces. Directions for several colors on various metals will be described below. The object may be painted or dipped into solutions. Due to many variables in individual metals, desired effects may be created through experimentation on scrap pieces of the same metal. Once the solution has dried, coat the piece with a clear preservative of lacquer, varnish, synthetics, etc., to preserve the color.

Before any solutions are applied, the metal should be thoroughly cleaned by either sanding, wire brushing, sandblasting, or acid pickling (described below.)

A. Copper (Clean)

Green:

Copper nitrate	2 oz.
Vinegar	1 oz.
Water	1 pt.

(Preheat solution)

B. Bronze or Brass (Clean)

1. Green:

Sodium chloride	8 oz.
Ammonium chloride	8 oz.
Ammonia	6 oz.
Vinegar (or acetic acid)	1 1/2 qt.

2. Brown

Barium sulphide	3 oz.
Potassium sulphide	1 oz.
Ammonia	6 oz.
Water	1 gal.

3. Blue

Lead acetate	2 oz.
Sodium thiosulphate	4 oz.
Acetic acid	2 oz.
Water	1/2 gal.

(Apply warm)

C. Iron (steel)

Brown (rust)

Natural weathering or

Strong salt solution in water.

WORK SHEET—METALLIC FORMATIONS I

Base Design and Creation

Most sculpture is created either freestanding, or mounted on a separate base. If your sculpture is of the second type, here are guidelines on the creation of a suitable base.

I. DESIGN:

A base should be designed to compliment the sculpture for which it is made. The design should be simple and direct. The base should not detract from the visual impact of the sculpture itself.

Some sculptors have a base in mind early when they are still welding the sculpture. However, the artist must remember that the base is designed to fit the sculpture; not the other way around.

Simplicity is the key word in the design of a good base.

II. MEDIA COMPATABILITY:

The next step in creating the base is to select the material from which it will be constructed. Basically, it is a matter of individual taste as to which material should be selected. As the design has already been selected, the next step is color and texture. For example, a smooth marble base is generally cream colored. (Some types of marble have pink or grey hues.) Certain metals apply themselves very well to a marble base.

A base of the same metal from which the sculpture was made sometimes works well. There are many types of wood (both finished and rough) that lend themselves to metal subjects.

Let artistic knowledge of color and design be a guide for selecting functional and outstanding base designs.

III. TEXTURE:

Do not limit your selection to finished materials alone. Experiment with coarse or unfinished surfaces. One may find that a smooth, polished sculpture may stand out very well against a rough or primitive base.

IV. MOUNTING:

A sculpture may be mounted directly on, or in a raised position above the base. Experimentation is the best guideline.

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Resources for Pupils

American Welding Society, Brazing Manual Two. Van Nostrand Reinhold, New York.

*Baldwin, John, Contemporary Sculpture Techniques. Reinhold Publishing Co., New York.

*Dennis, W.H., Metallurgy of the Ferrous Metals. Pitman Publishing Co., New York.

Graham, F. D., Welders Guide. Bobbs Merrill Co. Inc., Indiana.

Houldcroft, P. T., Welding Processes. Cambridge University Press.

Irving, D., Sculpture: Materials and Processes. Van Nostrand Reinhold, New York.

*Lancaster, Metallurgy of Welding, Brazing, Soldering. American Elsevier Publishing Co., New York.

Lynch, Metal Sculpture. Viking Press Inc., New York.

*Manko, H. H., Solders and Soldering. McGraw Hill Publishing Co., New York.

*Meilach and Seiden, Direct Metal Sculpture. Crow Publishing Co., New York.

Rood, J., Sculpture with a Torch. University of Minnesota Press, Minn.

Van Lancker, Metallurgy of Aluminum Alloys. John Wiley and Sons Inc., New York.

*Indicates materials desirable for classroom reference.

BIBLIOGRAPHY

Resources for Instructors

Note: Resources marked with an asterisk have been selected as most effective during previewing.

A. Movies, slides. (Available through Dade Co. B.P.I.—Instructional Materials Division.)

*Oxy-acetylene Welding: light metal			
21' BW	JS	EBCC	1-13093
*Resistance Welding			
12' BW	S	USBMA	1-05558
*Steel			
11' BW	JS	Almanac	1-04071
Iron Ore Mining			
15' C	EJS	Academy	1-11594
Twentieth Century Sculpture			
C	JST		5-20159

B. Textbooks

*Jansen, History of Art. Prentice Hall, 1962.

*Reed, Sir Herbert, Form Space and Vision. Grahm Collier, 1967 (state adopted text.)

*NOTE: Bibliography (Resources for pupils) marked with an asterisk should be included for instructors.